Air Quality Monitoring:

Agricore United Grain Handling in Vermilion

Jan-Apr 2007 **Final Report**

Overview

Residents near Agricore United's grain handling facility in Vermilion filed complaints with Alberta Environment of elevated particulate levels in the area. Following this complaint Alberta Environment deployed particle monitoring instruments at two sites in the area. Two particle size ranges were measured: Total suspended particulate matter (TSP) and fine particulate matter ($PM_{2.5}$). Alberta has a 24-hour ambient air quality objective for TSP; this objective was not exceeded during the study. The maximum TSP concentrations of 33 and 23 $\mu g/m^3$ at the two sites were notably lower than the 24 –hour air quality objective of 100 $\mu g/m^3$. $PM_{2.5}$ concentrations ranged from below detection limit to 113 $\mu g/m^3$, with 95% of the concentrations being equal to or less than 21 $\mu g/m^3$. The predominant wind directions during the sample period were from the southeast (SE), east southeast (ESE) and south southeast (SSE). Such meteorological conditions should have impacted one of the monitoring sites (**Site 1**) more than the other (**Site2**). However, both TSP and $PM_{2.5}$ concentrations were comparable at the two sites. The results imply that particle concentration in the area ***at the time of study*** had minimal contribution from the nearby grain handling facility. Sampling took place between January 27th and April 16th, 2007. The results of this study do not reflect potential ambient particle concentrations at the end of summer and fall when operation are alleged to be higher.

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Introduction

Particulate matter may be generated and released into the atmosphere during the moving, cleaning and/or drying of grain. Agricore United is the largest grain handling company in western Canada. Grain is moved though Agricore's facility at Vermilion year round, albeit operations are at a higher capacity during the late summer / early fall months. The Vermilion facility is located in close proximity (<500m) to residences. Residents of these homes have filed complaints with Alberta Environment of elevated dust/particulate levels in the area. To address these complaints Alberta Environment deployed particulate matter monitors to two locations near the Agricore United facility, where sampling was conducted between January 27th and April 16th, 2007.

Atmospheric particles are categorized into various size ranges, each affecting the respiratory system differently. Two particle size ranges were measured in the area of Agricore United Vermilion: Particulate matter less than 2.5 micrometer (μm) in aerodynamic diameter ($PM_{2.5}$) and total suspended particulate (TSP). The aerodynamic diameters for TSP range from 0.001 to 500 μm. $PM_{2.5}$ are small enough to penetrate deep into the lungs. The objective of monitoring $PM_{2.5}$ was to examine the contribution of emission from grain handling facilities to this particle size range. A significant fraction of the particles generated through grain handling is expected to be outside the $PM_{2.5}$ size range (with diameter much larger than 2.5 μm). TSP measurements monitored this remaining fraction. Alberta has a 24-hour average Ambient Air Quality Objective (AAAQO) to which measured TSP concentrations are compared.

Monitoring method and location

Monitoring was conducted at **Sites 1** and **2,** as indicated in Figure 1. Two *Partisol Air Samplers* were used to collect TSP, one at each site. A controlled flow passed though the instrument where particulate matter is collected on a filter. *Alberta Research Council (ARC)* prepared and analysed the filters. Concentrations determined from gravimetric analysis provided 24-hour average TSP concentrations.

$PM_{2.5}$ was monitored using the continuous sampler, *Beta-Attenuation Mass monitor* (BAM). The BAM provides real-time one-hour average concentrations. Two BAMs were used in this study, one at each site. Unlike the *Partisol Air Samplers*, the two BAM monitors were operated simultaneously.

Meteorological information obtained from Alberta Agriculture's meteorological tower is used in discussing the data collected. This meteorological tower has instruments mounted 10 m above ground and is located approximately 3 km from the monitoring sites. Meteorological measurements at this location are though to be representative of the conditions at the sampling sites. The location of this tower is indicated in Figure 1. Also shown in Figure 1 are the Yellowhead Highway (Hwy 16) and the town of Vermilion. Vehicular emissions in these areas are additional sources of particulate matter.

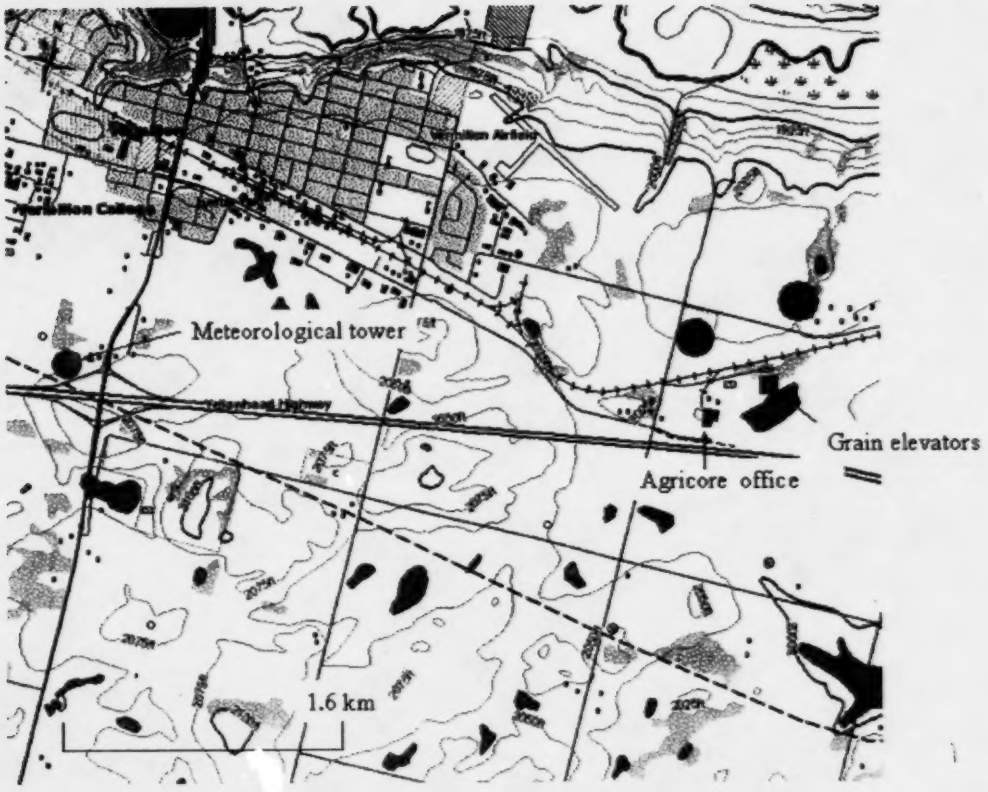

Figure 1: Map of sample sites. Green circles indicate location of particulate matter sampling equipment. The black squares indicate the location of buildings; Agricore office is indicated with an arrow as are grain elevators at the site. Alberta agriculture's meteorological tower is about 3 km west of the two sample sites. The base map for this figure was obtained from *The Atlas of Canada*[1].

[1] http://atlas.nrcan.gc.ca/site/english/maps/topo/map

Results and Discussion

A summary of TSP and $PM_{2.5}$ concentrations are presented in the box plots shown in Figures 2 and 3. Illustrated are the minimum, maximum, and 25th, 50th (median) and 75th percentiles. ***A key for interpreting these figures and a description of concentrations presented can be found in the appendix.*** In addition, concentration statistics are presented in Table A1 in the appendix. The wind direction and wind speed for the period of the study is shown in Figure 4. The prominent wind directions for the period of study were south-easterly (SE), south south-easterly (SSE) and east south-easterly (ESE). Figure 1 illustrates the location of the sample sites and Agricore grain elevators. The elevators were ESE of **Site 1** and SSW of **Site 2**. Thus, on average **Site 1** should have experienced higher influence from grain elevator emissions than **Site 2**.

24-hour TSP concentrations measured at the two sites did not exceed the ambient air quality objective of 100 micrograms per meter cubed ($\mu g/m^3$). The maximum 24-hour concentrations at **Site 1** and **2** were 33 and 23 $\mu g/m^3$, respectively. The median concentration at **Site 1** was 11 $\mu g/m^3$ and at **Site 2** was 12 $\mu g/m^3$. Overall, as is evident in Figure 2, there was not a significant difference between concentrations measured at **Site 1** and **2**. The complete TSP data set is shown in Table A2 in the appendix.

A similar study was conducted in Brooks, Alberta. 24-hour concentration measured near Brooks, Alberta (2003) ranged from 13 to 180 $\mu g/m^3$, with a median of 53$\mu g/m^3$. The Brooks study was conducted to investigate influence of emissions from a feedlot on the particulate level in the area, it is likely that concentrations at the site were also influenced by agricultural and road dust. Neighbours to facilities in both studies visually identified the presence of *haze/dust* periodically. The lower concentration in the Vermilion study may be due to reduced grain handling activities during the sample period (winter).

Elevated $PM_{2.5}$ concentrations were measured periodically at the two Vermilion sites. This being said, in general $PM_{2.5}$ concentrations at the two monitoring sites were comparable to other measurements around Alberta. Summaries of $PM_{2.5}$ concentrations are presented in Figure 3. Note that $PM_{2.5}$ concentrations are as *one-hour* averages. This finer resolution time scale captures the short-term increases in concentration. This is evident in the maximum concentrations, which are significantly higher than the 75th percentile shown in Figure 3.

Ninety-five percent of the data collected had concentrations equal to or lower than 21 $\mu g/m^3$, notably lower than the maximum concentration at **Site 1** (53 $\mu g/m^3$) and **Site 2** (113 $\mu g/m^3$). A median $PM_{2.5}$ concentration of 5 and 6 $\mu g/m^3$ were determined for **Site 1** and **2**, respectively.

The median $PM_{2.5}$ concentration at the Edmonton downtown air quality station, where samples are influenced by urban emissions, was 4 $\mu g/m^3$ for the same sample period. The median $PM_{2.5}$ concentration for recent air quality surveys conducted using the Mobile Air Monitoring lab (MAML) ranged from 2 $\mu g/m^3$ (Girouxville and Whitecourt[2]) to 6 $\mu g/m^3$ (Caroline). In addition to grain handling, motor vehicles in the area are also a source of $PM_{2.5}$. Figure 5 illustrates $PM_{2.5}$ concentrations during a segment of monitoring when concentrations were higher than average. Figure 6 illustrates the wind direction and speed at the time. The more frequent wind direction was from the east southeast, thus emissions from Agricore United should influence samples at **Site 1** more than samples at **Site 2**. This was not evident in Figure 5; concentrations at the two sites were comparable and correlated. This suggests that particles at the two sites had the same sources. TSP measurements suggested emissions from Agricore United had limited impact on particle concentration in the area ***at the time of sample***. The most likely source of $PM_{2.5}$ concentration measured during the study is vehicle emissions. Note that the Yellowhead Highway is due south of both sample sites.

The results of the study imply that particle concentration in the area ***at the time of study*** had little contribution from the nearby grain handling facility. The lower particle concentration could have resulted from reduced activity level at the grain elevator during the sample time. Sampling took place between January 27th and April 16th, 2007. The results of this study do not reflect potential ambient particle concentrations at the end of summer and fall when operations at the facility are alleged to be higher. Furthermore, due to sampling difficulties and instrument malfunctions there were gaps in the data collected (Table A2).

[2] Special air quality monitoring report can be found on the department's website at http://www3.gov.ab.ca/env/air/AmbientAirMonitoring/reportssurveys.html

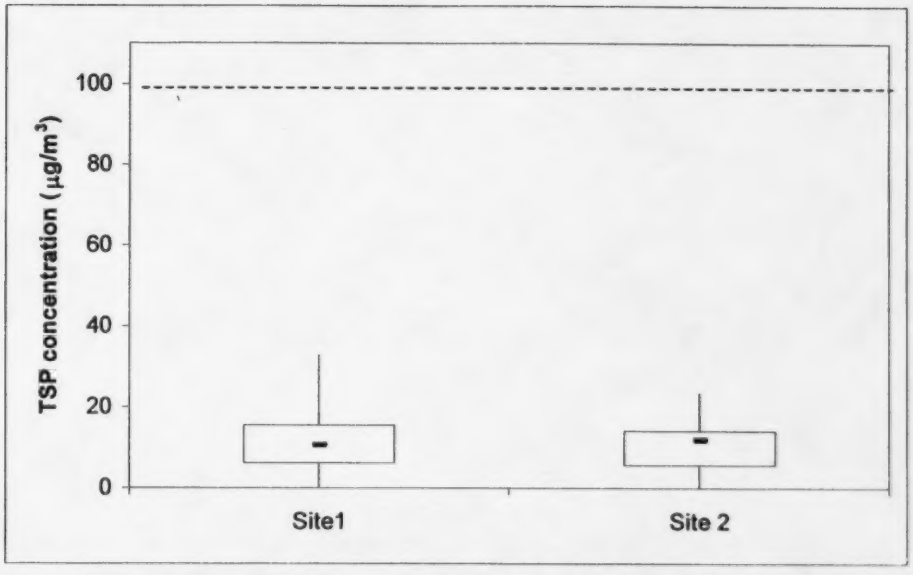

Figure 2: Summary of the 24-hour average TSP concentrations at the two monitoring sites. Presented are the minimum, maximum and 25th, 50th (median) and 75th percentiles. The broken line indicates Alberta's 24-hour TSP objective.

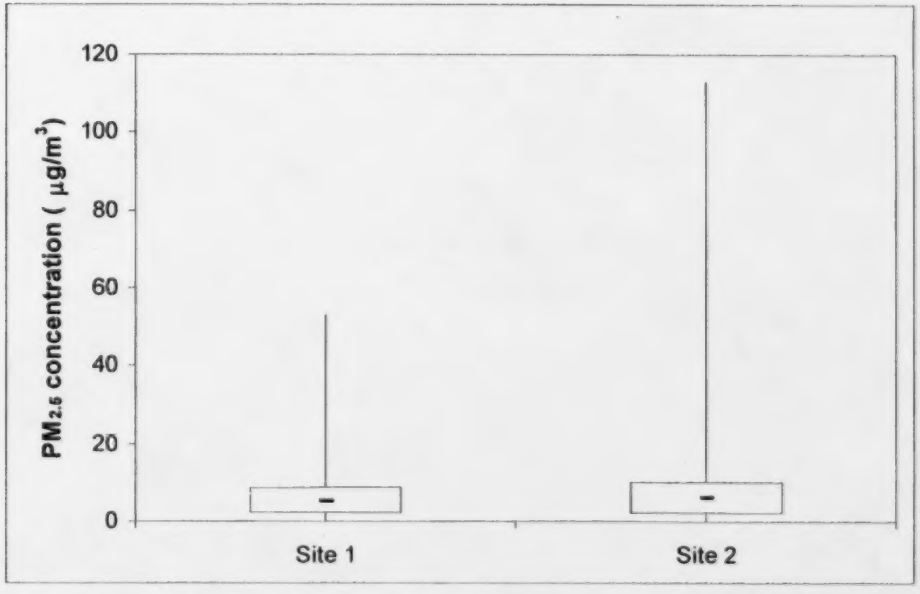

Figure 3: Summary of the one-hour average $PM_{2.5}$ concentration at the two monitoring sites. Presented are the minimum and maximum, and 25th, 50th(median), 75th percentiles.

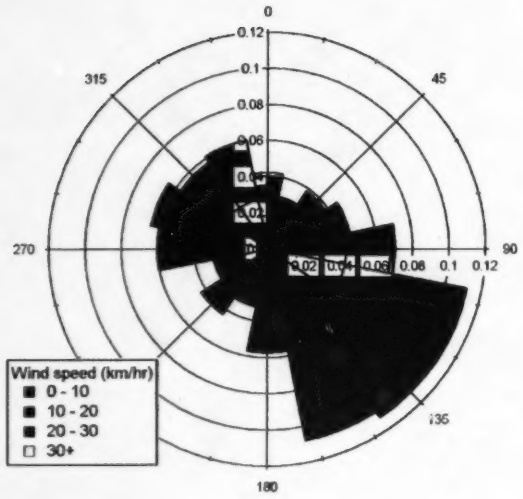

Figure 4: Wind direction and wind speed during the whole sample period. The predominant wind directions were east of southeast, southeast and south southeast. For these wind directions the wind speed was mostly between 10 and 30 km/hr.

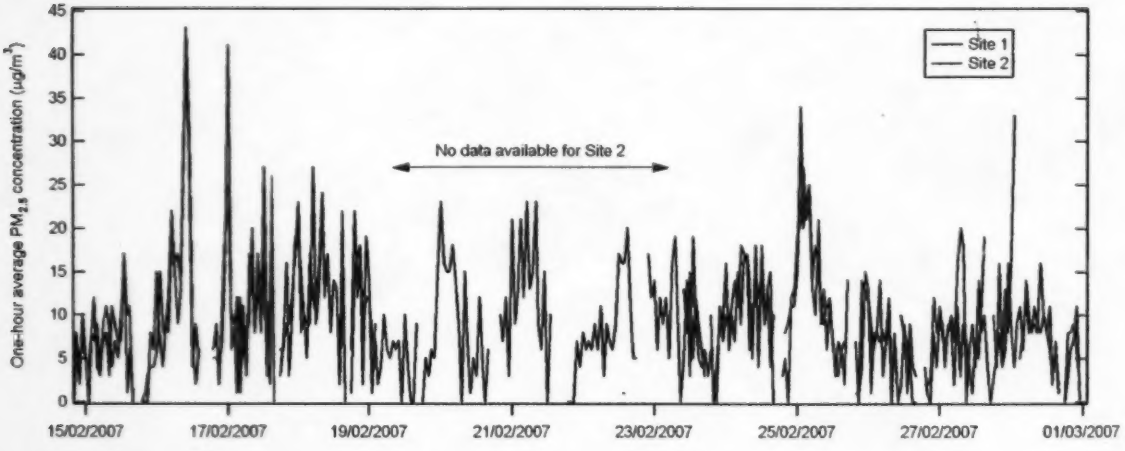

Figure 5: One-hour $PM_{2.5}$ concentrations at Site 1 and 2 for a segment in the sample period when concentrations were higher than average. There were no data available for Site 2 from February 19th to 23rd. Concentrations at the two sites were highly correlated.

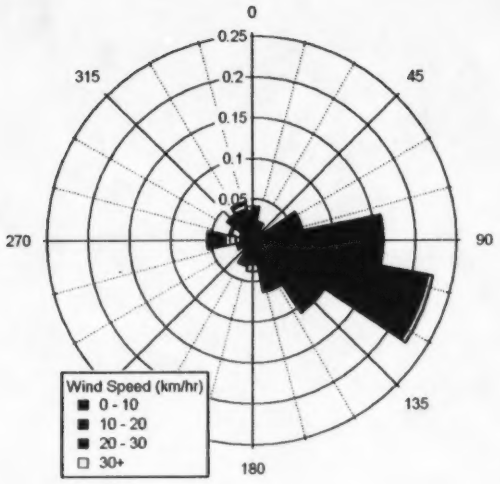

Figure 6: The wind direction and speed for the sample period represented in Figure 5. The predominant wind direction was from the east and east southeast.

Acknowledgements

Alberta Environment would like to thank students of Lakeland College for their help in performing *Partisol Air Sampler* filter changes.

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Appendix A

Representation of measured concentrations

Measured concentrations were used to calculate the maximum, median, minimum as well as the 25th and 75th concentrations at each monitoring site. The 25th percentile indicates the concentration below which 25% of the data occur. In the same way, the 75th percentile is the concentration below which 75% of the data occur. The median indicates the mid value of the data, half of the data is above the median value and the other half is below. Figure A1 explains the graphical representation of these data. Figures containing these statistics are often useful in depicting the data set as a whole. For example, variability in the data, a significantly high maximum and/or low minimum are readily apparent in these figures.

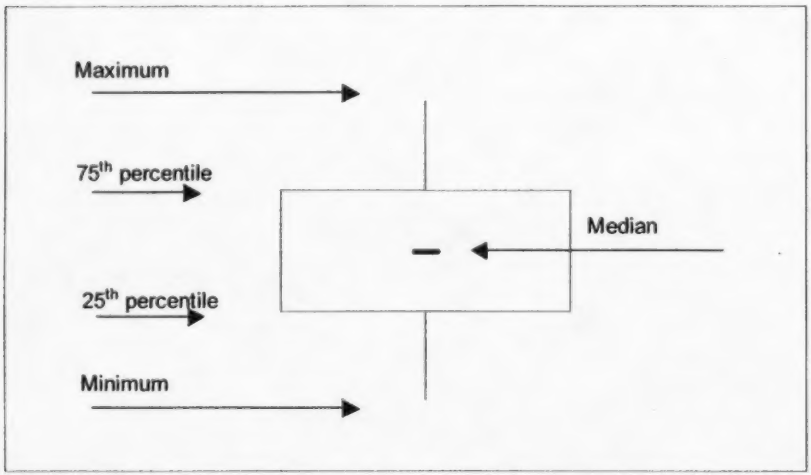

Figure A1: Key for the interpretation of graphical data.

Table A1: TSP and $PM_{2.5}$ concentration summary for Site 1 and 2. TSP values are calculated using 24-hour average concentration, $PM_{2.5}$ are calculated using one-hour average concentrations.

Unit =µg/m^3	Site 1	Site 2
TSP		
Min	0	0
25th percentile	6	6
Median	11	13
75th percentile	16	23
Max	33	23
PM2.5		
Min	0	0
25th percentile	2	2
Median	5	6
75th percentile	9	10
Max	53	113

Notes: µg/m^3 – micrograms per meter cubed

Table A2: 24-hour average total suspended particles at the two monitoring sites (Figure1).

Sample period		*Site 1*	*Site 2*
Start	End	$\mu g/m^3$	$\mu g/m^3$
27-Jan-07	28-Jan-07	n/a	8
28-Jan-07	29-Jan-07	n/a	4
29-Jan-07	30-Jan-07	n/a	9
30-Jan-07	31-Jan-07	n/a	24
1-Feb-07	2-Feb-07	n/a	3
2-Feb-07	3-Feb-07	n/a	bd
3-Feb-07	4-Feb-07	n/a	13
4-Feb-07	5-Feb-07	n/a	14
6-Feb-07	7-Feb-07	bd	n/a
7-Feb-07	8-Feb-07	bd	n/a
8-Feb-07	9-Feb-07	bd	n/a
9-Feb-07	10-Feb-07	8	13
10-Feb-07	11-Feb-07	12	bd
11-Feb-07	12-Feb-07	6	bd
12-Feb-07	13-Feb-07	8	n/a
13-Feb-07	14-Feb-07	16	14
14-Feb-07	15-Feb-07	6	11
15-Feb-07	16-Feb-07	13	12
28-Mar-07	29-Mar-07	5	n/a
29-Mar-07	30-Mar-07	12	n/a
31-Mar-07	1-Apr-07	33	n/a
1-Apr-07	2-Apr-07	9	n/a
2-Apr-07	3-Apr-07	30	n/a
7-Apr-07	8-Apr-07	3	n/a
8-Apr-07	9-Apr-07	8	7
9-Apr-07	10-Apr-07	16	15
10-Apr-07	11-Apr-07	18	15
11-Apr-07	12-Apr-07	13	17
12-Apr-07	13-Apr-07	14	8
13-Apr-07	14-Apr-07	27	23

Notes: bd – below the detection limit of instrument used
n/a - no data available
$\mu g/m^3$ – micrograms per meter cubed